Kinetic and Mechanism Studies of U(VI) Bearing Groundwater Treated with Sodium Silicate at the Savannah River Site

Alejandro Hernandez- DOE Fellow, Mentors: Dr. Yelena Katsenovich and Dr. Vasileios Anagnostopoulos

Background

- The Savannah River Site (SRS) was one of the most significant sites for the production of materials related to the U.S. nuclear program during the early 1950s to late 1980s.
- An estimated 36 metric tons of plutonium were produced, and 3.4 billion gallons of hazardous waste solution were received in the F and H areas.
- The constituents of concern (COCs) associated with the F and H Area HWMF groundwater plume are uranium-238, tritium, iodine-129, strontium-90, curium-244, americium-241, technetium-99, cadmium, and aluminum, and mercury.

Objectives

1. Explore the application of sodium silicate for the restoration of the alkalinity of the treatment zone.
2. Investigate the immobilization of COCs, concentrating on U(VI).
3. Elucidate the sorption properties of U(VI) on SRS soil at circumneutral conditions, through kinetic and mechanistic studies.

Materials and Methodology

Sorption experiment

- Batch experiments were conducted bringing in contact:

3 Different SRS Soil Fraction		
d<63 µm	63µm<d<180µm	180µm<d<2mm
2 Synthetic Mixtures		
Quartz	95 % Quartz and 5 % Kaolinite	

- VI), amended with sodium silicate to circumneutral conditions (pH~6.5).

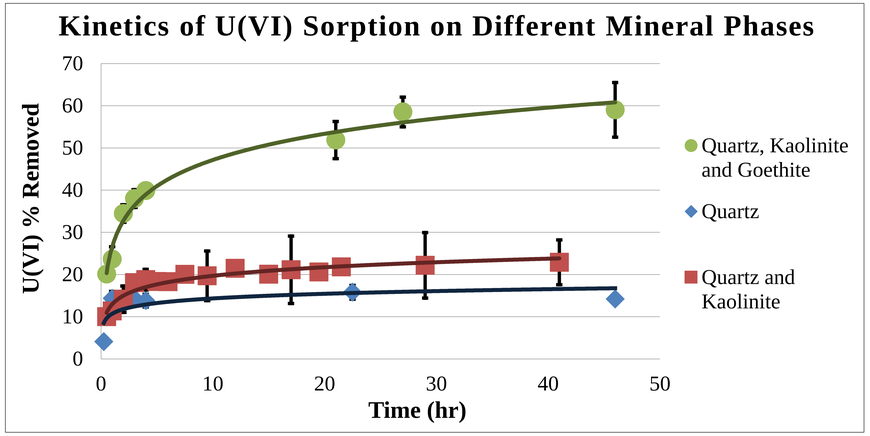
Desorption experiments

- Supernatant was removed from

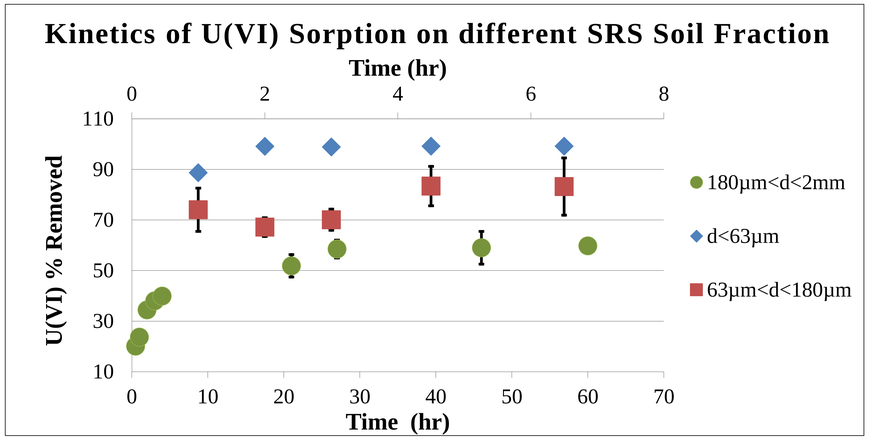
2 synthetic mixtures	
Quartz	95 % Quartz and 5 % Kaolinite
SRS Soil Fraction	
180µm<d<2mm	

- SRS synthetic ground water was reintroduced, and left to equilibrate for 26 hours.
- U(VI) analysis of all samples was performed through Kinetic Phosphorescence Analysis (KPA).
- Solid: Liquid ratio was kept constant throughout the experiments and equal to 20:1 and all experiments were performed in triplicates.

Results



Desorption	
Quartz, Kaolinite and Goethite	50%
Quartz and Kaolinite	100%
Quartz	100%



SRS Soil Fraction	U(VI)% Removed	[Fe] in the Soil (mg/g)
d<63 µm	100 %	89.1
63µm<d<180µm	80 %	70.2
180µm<d<2mm	60 %	40.0

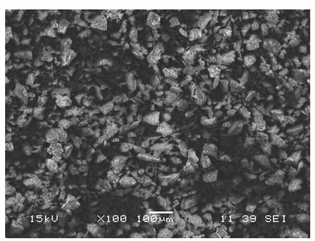


Figure 1 SRS Soil Fraction: d<63 µm

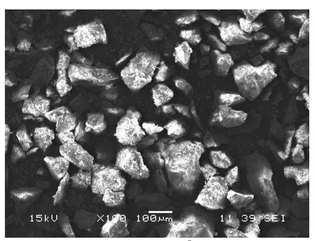


Figure 2. SRS Soil Fraction: 63µm<d<180µm

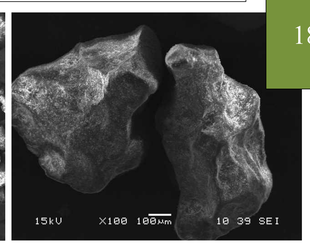


Figure 3. SRS Soil Fraction: 180µm<d<2mm

- ✓ Alkalinity restoration using a **cost-effective** & **environmentally benign** technology.
- ✓ Provides greater insight on the geochemical interactions of U(VI) with SRS soil.

Conclusions

- ❖ Goethite (iron bearing oxyhydroxide mineral) is proportional to the [Fe] in the soil.
- ❖ Goethite is the most reactive mineral phase of SRS soil involved in U(VI) retention.
- ❖ U(VI) is strongly retained by goethite.
- ❖ Positive correlation between the iron concentration in the soil and U(VI) sorption.

ACKNOWLEDGMENTS

Dr. Yelena Katsenovich
Dr. Vasileios Anagnostopoulos
Dr. Ravi Gudavalli
Dr. Leonel Lagos
FIU - Applied Research Center
Savannah River National Lab
DOE-FIU Science & Technology Workforce Development Program

This research was supported by the U.S. Department of Energy Office Of Environmental Management - Office of Science and Technology.

CONTACT INFORMATION
Alejandro Hernandez–DOE Fellow
Applied Research Center
Florida International University 10555 West Flagler Street, Miami, Florida 33174
Aleherna@fiu.edu